Menlo Park Notebook #41.2 [N-79-10-18]

This notebook covers the period October 1879-February 1880. Most of the entries are by Francis Upton. There are also entries by Edison, Samuel D. Mott, and John Kruesi. All of the material relates to electric light and power experiments. Included are notes, drawings, and calculations about generators; notes and calculations relating to tests of sewing machine motors; notes, drawings, and calculations on electric power distribution; and notes on testing wires. The label on the front cover is marked "Faradic Machines No. 3" and "Upton." The book contains 284 numbered pages.

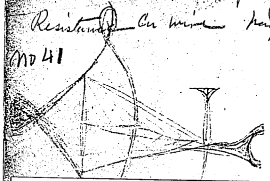
Blank pages not filmed: 262, 265-275.

Missing page numbers: 167-168, 263-264.

Heat developed page 2[redacted]

Resistance Cu wire page 15

No 41



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[illegible]

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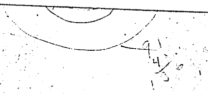
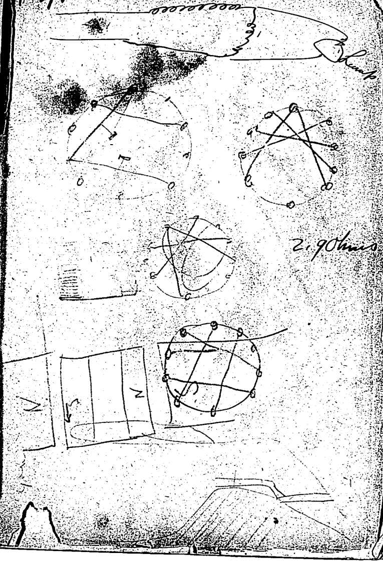


1041

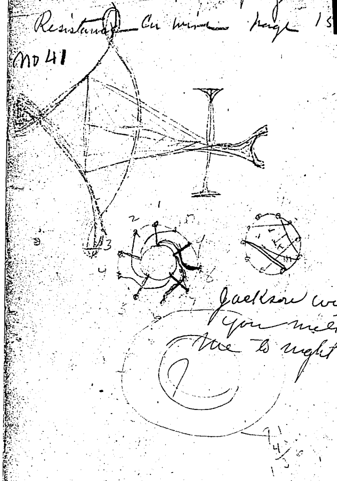


2.90 ohms

Heat developed page

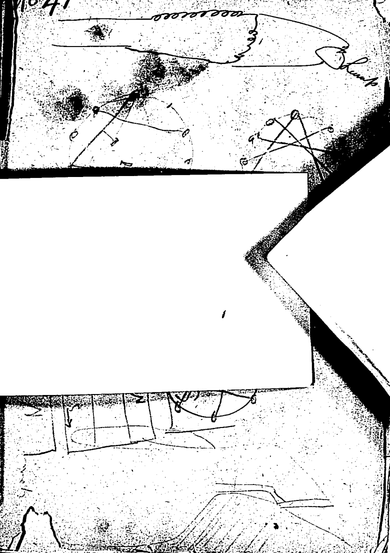
Resistance Cu wire page 1

No 41



Jackson wil
you meet
me to night

No 41



4.75	.6767
comp's 16.	8.7959
450	2.6532
3.14	.4969
	2.6227
2	.3010
	2.9237

838 ft. lbs

Sewing machine motor

450 revs.

Wt 1 foot from axis

$4\frac{3}{4}$ oz

$\frac{4.75}{16}$ lbs

838 ft lbs given off to the Prony when the friction wheel was held still. Probably very poor determination. Yet it shows that only about 1/4 of the power absorbed by the machine is given off.

0

0 0

Resistance of machine

337 : 674 :: 6.08 : X

674
6.08
337

X = 12.08 Ohms

27 = deflection 3 Daniells

3.4 over 6.0.8 Ohms

29.6 over machine

Running Machine through leather

3.41

276

.31

.8325
.7839
.0486
.0486
.7839
1.6464
2.5275 337 foot lbs

337
296
comp 34

2.5275
2.4713
8.4685
3.4673 2930 /

337
2
674

2256 3.3534
2930 3.4669
.8865

33.000 4.5185
3 3534
1.1651
4.5185
3.4669
1.1116 $\frac{1}{13}$ H.P

Motor sewing leather

3.4
2
6.8 Volts

6.8
6.08

1.11 Webers

337 foot lbs. given off from the resistance

34 ; 296 ; ; 337 : X

X = 2930 ft. lbs. consumed on machine

2930
674
2256 in power

75% of power entering machine in work

$\frac{1}{14}$ H. P work

4.5185
3.1195
1.3990

Results

Running free
Total 1317 ft lbs. 1/25 H.P
Resistance 122
Sewing leather 90.%
Total 2930 ft lbs 1/13 H.P
674
Pulley held fast 75%
Total 3723 ft lbs 1/9 H.P
1460
60%

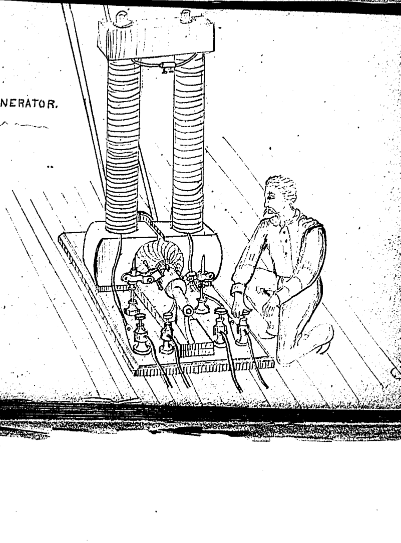
(seven) cells of battery ran the motor slowly.

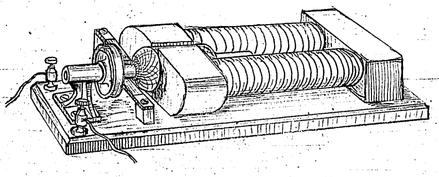
Wanted — A measurement of the power that various sewing machines take to drive.

1000 feet per minute on wheel 4 feet in circumference 250 times per minute

Test for motor Prony to measure power absorbed

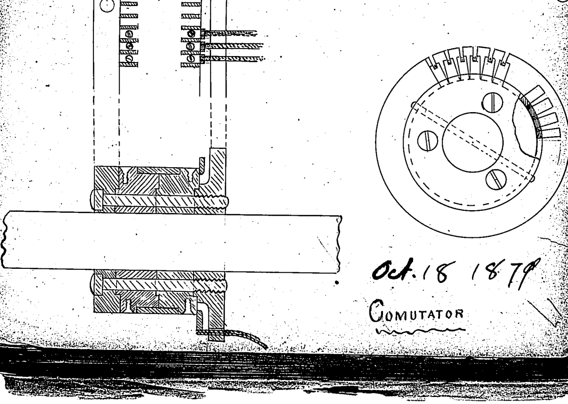
EDISON'S ELECTRIC GENERATOR.





Edison's Electric Motor. No. 1

Copied from working drawing



Oct. 18 1879

COMUTATOR

Faradic Motor No. 2

Resistance = 17.9 Ohms
to 17.5 Ohms
same all round Oct. 20, 1879.

Wound with wire = .042 in
on magnet No. 19 6 & 7
on armature No. 24 .022
~~[illegible] Ohms~~ 11. Ohms

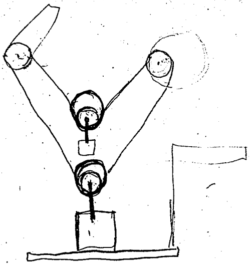
~~27 coils~~ 8 layers
25 coils 6 in coil
Page 109

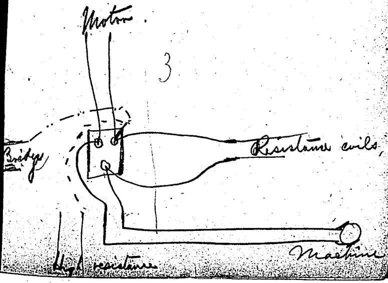
$$\begin{array}{r} .022 \\ 3 \\ \hline .025 \\ 8 \\ \hline .200 \end{array}$$ wire covering

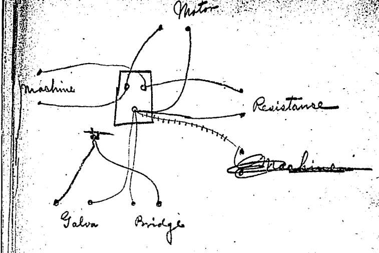
$$\begin{array}{r} 17.9 \\ 8.8 \\ \hline 9.1 \end{array}$$

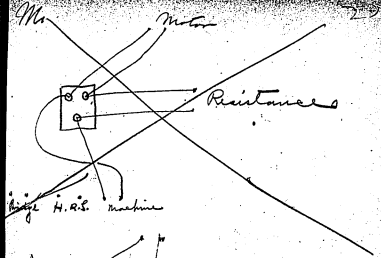
About 9.1 Ohms taking the resistance at [illegible] point from

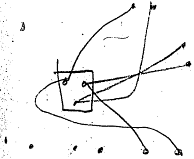
Drawing of Motor No. 2




Motor.
3
Bridge
Resistance coils,
High resistance
Machine


Motor
Machine
Resistance
Machine
Galva
Bridge


Mo
Motor
Resistances
Bridge
H.R.S.
machine



1.64591
4.51851
7.12740

1460 ziro

1.1
4.5

Same current through
No 1 & 2 Motors

No. 2 1100 revs
No 1 scarcely moving

This seems to be owing to the
way of bringing up the magnets

Again No 2 scarcely moving
No. 1 2010

No. 2 Whole current on
400 revs. Dead point tried ~~to~~ remove
by having more pressure

Resistance	13.2	19.
	16.2	16
	17.9	16.7
	19.1	10.6
	19.5	8.8
	19.5	12.4

Wheels on No 1 & 2

$$2\,\underline{)\,8.25}\ \text{inches}$$

$$.687\ \text{feet}$$

Tried a dynamometer with small wheels dead failure too much play in wheels due Cross found in No. 2 Motor Cotton covered wire ordered so as to avoid crosses

[illegible]
~~[illegible]~~

No. ~~7~~

No. ~~3~~

.03.125
7
.21.855

9 7/32 = 9.218
9.02
.198

1.49
9
1.40

8.75
.27
9.02 Between wire & Face

.045
6
in .270 Thickness of wire

9 7/32 in. bore for armature

Wood in armature 6 1/4 inches

Iron ring 1 1/4 inches thick

Diameter armature 8 3/4 = 8.75

9.218
8.75
.468 Iron core from face armature

~~6.02~~ Measure Dec 11 page 120

.81 Measure Dec 13

Mr. K gave
me this wh.
does not seem
be correct

Faradic Machine No. ~~2~~ 1
Round wire core
Made

Dimensions &c

Ohms

Magnet ~~[illegible]~~ .91
coil warm
Armature 1.13
coil cooler 1.11 - 1.13

Magnet wound .135 in diam

Two layers 240 turns ~~count~~
2
480

core 6 in+ diam

~~Arm~~

Armature wire .032 in average
covering .013
Total .045

39 coils Three wires wound together six layers.

39
12
78
39
468

.055
6
.330 Thickness wire

8.75
.33
9[illegible]8 9 3/8

9.375
9.18
.195 Wire from face

Round wire

21½ inches whole length of back
14 inches centre of cores

Length armature face of magnet 9¼ inches

Armature wire ¼ inch longer

Iron inside 8½ inches long

Wood in ~~armature~~ 6¼ in diam

Iron ring 1¼" thick

Diameter armature 8¾ inches

9.375 140 : 110 very nearly as .625 : .468
8.75
2)1625 Distance Iron from face
312

624

940 measure Dec 11

Mr. K gave this measure which does not seem to be correct

Faradic Machine No. 2

Made began Aug 1879 finished Sept 1879
with large wire on armature
Running fast the coil heaving loose and caught on poles tearing the wire up.

Armature removed
Dimensions &c

Resistance
Temp about 70°
Magnet 1.4 Ohms
Armature .62

Magnet wound .135 in diam
Three layers ~~2[illegible]~~ 234 turns in each layer
3
Total No. turns 702
2
1404

calculated
564 lbs bars
253 " back

~~Diameter core six inches~~
~~Length " three feet~~
Back 6 X 7 in

Armature 39 coils ~~.042 inches~~
~~with~~ diameter wire .042 in
covering .013
.055
Six layers two threes

(8.3329
2(4.1664
~~2.0832~~
.7198 3.4466
~~1.3634~~

32 1.5051
6.1 .7853
.7198

(85010
(4.2505
~~2.1252~~
.7970 3.4535
~~1.3282~~

26 1.4150
4.15 0.6180
.7970

(9.30558
4.6529
1.2041
3.4488

(8.9180
4.4590
.9956
3.4634

3.4535
.9800
3.4735

4.2505
.9800
3.2705

29.8 1.4742
3.12 0.4942
.9800

Tests

~~5 cells 108 55~~
~~X = 12 poor cells and 216 110~~
~~17 cells = 1 165~~
~~Make 33~~

5 cells

3.4450

~~5.9~~
32 Volts ~~around~~ 6.1 Ohm

Elec Dyne 1° 14' 3.4466

~~26 Volts and 4.15 Ohms~~

Elec Dyne 1° 4 9'

29.8 on 3-12

~~3° 5 8'~~ 4° 45' ?
9.9 Weber
3.4634

11° 40' 16 Webers
3.4488

54)113 2.0531
54 1.7324
.3207
2.09
5
10.45 0.6990
108 .0334 108/540
1.0531

11.13
5.4
16.53

My Dear Sadie
Will you
meet me to night
at the north

Jackson

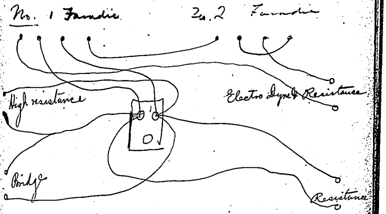
No. 1 Machine 535 revo.

from Magnets 7.5 Volts
without any current on field

$\left(\frac{113}{54} + 5\right)$ Daniells ~~gave a~~ made to give deflection of 33

16.53 Volts D = 33
1 Volt D = 2

Plan


No. 1 Faradic
No. 2 Faradic
High resistance
Electro Dyn & Resistance
Bridge
Resistance

4

Resistance 9.1) 4.00 (.43 Webers

360

340

On field 2 ~~158~~

29

5.4 .7324

5.4 .7324

.92 1̄.9638

44.3 1.6468

3.0756

1.6162

945 ft lbs

~~8476~~

1.4624

.8476

.6148

7.04

29

~~4.16~~ 4.12 Weber

118

23

11.5

11.5

1.0607

.8476

.2131

1.63

3.5 Volt / 12.2 Ohms

1.0864

1.43 77

80

283

7.2) 40.0 (54

360

340

288

.520

No. 1 Machine

On Field No. 1 .43

From Armature 5.5 Volts

Do not understand

On Field 4.12

From Armature 8.3. Volt

On field 1.63 Webers

From Armature 5.9.

From Armature 10 Volts
after the magnet had been left
from the last current

On Field .28 Weber

From Armature 13.5 Volts

On Field 1948 ft lbs 5.4 Webers

From Armature 101.5 Volts

Bad Sparks on the top of the commutator

257
123
7.4

62.5
7.4

1.7959
.8692
.9267

1.7709
.7745
.9964

273
118.
59 over 5.95

.9964
.9964
1.6102
3.6030

4010

4.5185
3.6030
.9155

282 141

111
56.5 1.7443
4.94 6937
1.0506
1.0506
1.6102
3.7114

4.5185
3.7114
.8071

4.5185
3.8406
.6779

1292
146 103 51.5
51.5 3.95

1.7118
.5966
1.1152
1.1152
1.1152
1.6102
~~[illegible]~~4
~~3.3[illegible]~~
3.8406

No 1 525 revolutions
from Armature 128 Volts
On Field 8.44 Webers

---

from Armature 136 Volts
On Field 9.9 Webers

on magnet
4010 ft. lbs.
8.2 per H.P.

---

from Armature 141 Volts
11.2 Webers 6.4 per H.P

---

146 Volts
13 Webers 4.7 per H.P

~~1~~88 1.9445
2.75 .4393
1.5052
2 .3010 45185
1.2042 4.0186
1.2042 3999
1.6102
4.0186

36 6.5 .8129
13 1.03555
10.84 .7774

49 11.5 1.0607
23 10.84 1.0355
1.0242

105 23.5 1.3711
47 1.0355
.3356

150 Volts
16. Webers 2.5 per H.P

18 Volts
.6 Weber

~~[illegible]~~ 1
from Armature 24.5 Volts
in Field 1.06 Webers

52 Volts
2.14 Webers

175
~~[illegible]~~ × 5 = 875
~~100~~
20

5
13.75
1.08

287
286

11000
.1375
14.8500
2
29.70

1.08
5
5.40
103
47

1) 80

197
~~89~~
286

2.2945
1.9494
.3451
.0334
.3785

103
47

22.1

2) 23.9 Volts
11.95 Volts
5.40
17.35
2
34.70

175
37.5

10.1) 200 (19

167
120

.40 1.6021 101) 235 (232
9.36 .9713
.6308

202
330
303
270

55
2.75

135
62.5) 65
325

Oct 28 1879 No. 1 magnets
5 Daniells 100 510 Leno.
175
X

14.8 Volts

---

1 Volt made to give
2° deflection

37.5 Volts
1.9 Webers

51.5 Volts
2.32

60. Volts
2.7 Webers

62.5 Volts
3.2 Weber

83 Volts
4.27

80 L

90
45 1.6532
.9713
.6819

51.5 1.7118
.9713
.7405

57.5 1.7597
.9713
.7884

115
57.5 1.7597
7.54 .8774
1
.8823

57 1.7559
6.7 .8261
.9298

56 1.7482
5.04 .7024
1.0458

53 1.7243
4.74 .6758
1.0485

---

90 Volts
4.8 Webers

180
90
~~180~~ Ω

98 Volts 196 R
On Field 5.5 Webers 103 Ω
9.36 Ohms

106 Volts 213
6.14 Webers 115 Ω

520 revs 127 Volts 7.54 Ohms 25.5 ?
7.62 Webers 115 Ω

125 Volts 250 Ω
8.5 Weber 414 R 6.7 Ohm

126 Volts 252 R 67
8.52 115 Ω

133 Volt 5267
10 112 5.64

137 Volts 275
106 4.74
111

51 1.7076
3.08 .4886
1.2190
1.2190
1.6102
4.1482

4.5185
4.1482
.3703

201. 2.3032
86.5 1.9370
0.3662
.0334
.3996

23
5

108
23
324
2.6
24.84

25 Volts

2/25
12.5
5.4
17.9

.6990
.0334
.7324

267 | 133 No. 1 Machine
134 | Magnets
5.64

290 145 Volts 23 Rev H.P.
102 16.5 Weber 3.08 Ohms

51 1.7076
3.6 .5563

1.1513
1.1513
1.6102

3.9128

4.5185
3.9128

.6057

---

51 1.7076
3.84 .5843

1.1233
1.1233
1.6102

3.8568

4.5188
3.8568

.6617

~~54.19~~ 54 1.7324
19.5 .2900

1.4424
1.13 .0531

1.4955

2

4)104
26

3)54

13.3
7

93.1 Volts

~~14.1 Webers~~ 102 3.6

~~4 Magnets per H.P. on No. 1~~

~~13.3 Magnets to~~

13.3 Webers

4.6 Magnets per H.P.

108 54 Volts
162 81

2.77 Webers
138 Volts

13.3 1.1239
1.1239

4.78 .3

99

279
837

8649

3303 Ohms
39 Ohms

96
3.80

3)48
3.8

1.16812
0.5798
1,1014
1.1014

12.6

273
1.365
39.

39
2.1335
1,5911
.5424

270
293

3.4
40.13

.6034
1.1458

270
135

264
20
132 V
6.6

135 2.1335
29.3 1.4669
1,1 .6470
304 1.4771
2.1241

2.1305
1.4669
.6636
1.4771
258 2.1407

~~No. 2 Machine~~ No. 1, Machine

page 31

12.6 Webers on magnet

34 Webers in the circuit
140 Volts
136.5 Volts
39. Ohms

4.4 Webers in the circuit
138 Volts
135 Volts around
29 ohms

6.6 Webers in the circuit
140 Volts
132 Volts around
20. Ohms

8.9 Webers in the circuit
137 Volts
128 Volts
on 14.3 Ohms

9.8 Webers in the circuit
135 Volts
126 Volts
on 12.8 Ohms

1.08 Webers 134 Volts	122 Volts 10.7 Ohms
1.2 Webers 130 Volts	120 Volts 9.7 Ohms
1.3.8 Webers 134 Volts	119 Volts 8.6 Ohm
1.5.3 Webers 135 Volts	117 Volts 7.6

141 Volts extremities $R = \infty$

112

17.700 ft. lbs. were given off from the armature of No. 2 machine for ten minutes in stopping heat about that of melting sealing wax.

1X ~~50~~

5 35'

~~2244 ons 9.3 ohms~~

105 Volts on 9.3 ohms

~~9.3~~

Constant E.D. $\bar{2}.4450$

9.6989

$\bar{1}$.8494

$\bar{2}$.4450

25 Webers 1.4044

.5 1.4044 ~~775~~

$\bar{1}$.6990 7924

1.6464 6990

4.1546 .0934

14.200 .0934

4.2486

17.700

Page 73

6. layer two. Three

1.4

Two layer

two three

66.

10 10 12 6 cell.

44
400
4/17600.
4.400

100

40/4400 (110
40
40.
40
00

144
44
576
4400 576
2/633.6.
3168.

6

1 2/10.

10 per hp

1 Calland . 2 . ohms
2 ohm Sounder.
22 foot lbs in latter

2/44.
22.

1 Carbon: 2/10 ohm
2 ohm sounder.
78 foot lbs;

44
4
2/10/176.
77

10 - calland 20 ~~ohm~~
20 ohm sounder 55 ~~ft~~ ft lbs outside.

1 6/10

15.4/10

100

10 carbon 2 –
20 ohm sounder.
800 ft lbs.

40/4400 (
110,

55,

20
20
400.

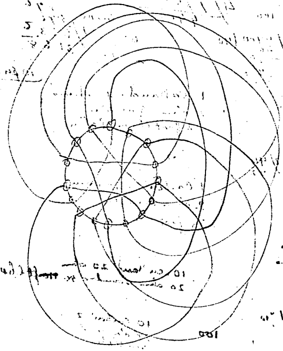
22
800
17.600

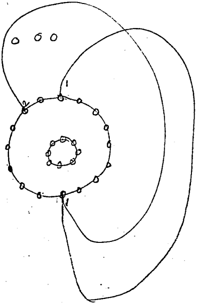
11
40
440

110
40
4400

44
400
22/17.600 (8
176

15,

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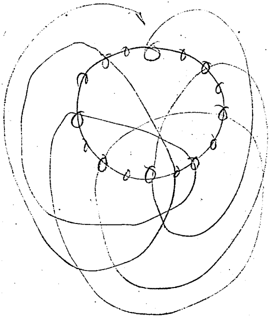
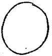
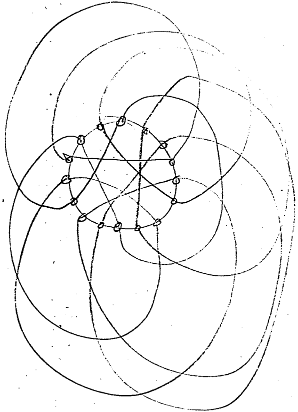
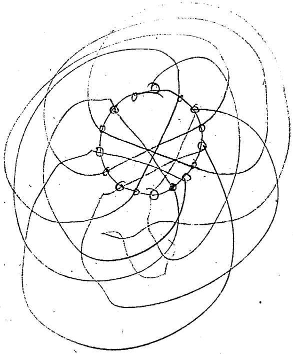
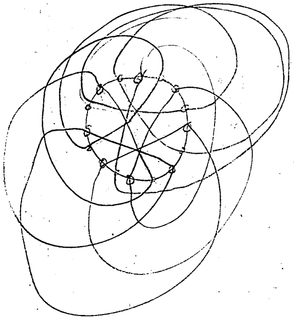
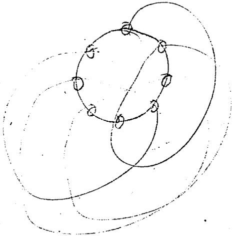


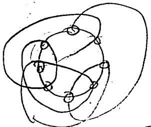


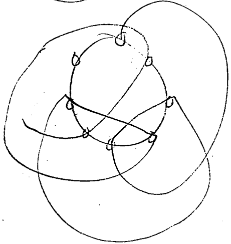


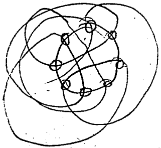


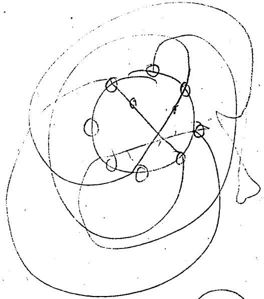


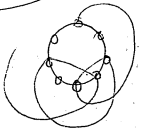


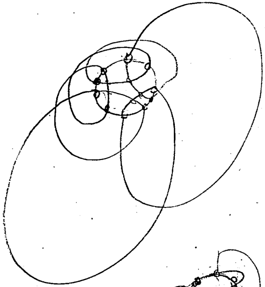


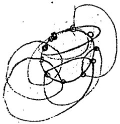


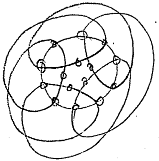


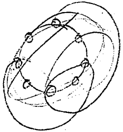


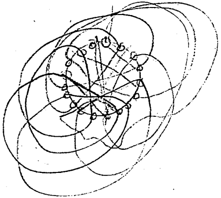


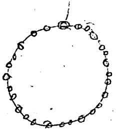


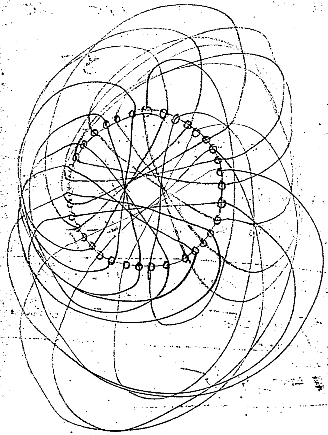












140 Volts from Armature

No. 1. Machine

115 Volts
around
8.7

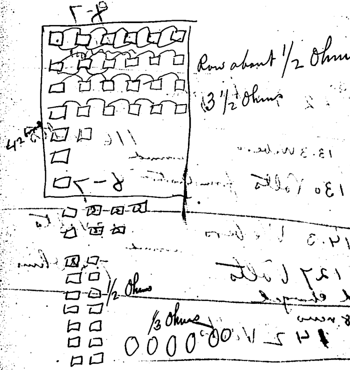
7.13 in Armature

Oct. 30
142 Volts from Armature
R = 60.000 Ohms

13.3 Webers
116 Volts
around
130 Volts from Armature 8-7

14.3 Webers
112 Volts
around
127 Volts
7.8 Ohms
speed changed

498 revs
142 Volts


8-7
Row about 1/2 Ohm
3 1/2 Ohms
42
8-7
1/2 Ohms
1/3 Ohms
0000

Method pursued

The resistances placed in the direct circuit from the armature. The extremities of the galvanometer placed at the binding posts of the machine. The galvanometer used so that 2° represented a Volt. The deflection then had only to be divided by two to obtain the ~~deflection~~ number of Volts active outside.

108 2.0334
69. 0.7709
1.2625
7. .8451
2.1076 128 Volts
60
2.1136
102 2.0086
5.1 0.7076
1.3 1.3010 200
6.4 .8062
2.1072

16 Webers 112
130 Volts 7 Ohms

106
5.7 Ohms

Made a ground at Galva
to make the Electrometer
effect ~~[illegible]~~ the same for
battery and Machine

145 Volts 60.000 Ohms
111 Volts

143 Volts
108 Volts
18.6 Webers 5.9 Ohms
130 Volts
20. Webers 102 Volts
128 Volts 5.1

78

96 1.9823
4.2 .6232
1.3591

1.3 5.5 .7404
2.0995 1.3591
2.0995 1.3591
.7404 .7404
1.6464 1.6464
4.5888 5.1055
4.5185
.5865

~~38000~~ 27000

3.8 H.P.

On magnet 6° 8' 1.2 140 Volts
44
6° 5' 21" (9.1363

4.5185 4.5681
3.8957 3.4450
1.1231
.7228

1.7

.9737
.6464
3.8087

---

498 revs 1967 79

22 Webers 96 Volts

125 Volts 4.2

3.8 Horse Power in the last case absorbed by the circuit

On magnet 13.3 Webers

6390 ft lbs

5.1 per H. P.

~~Elec~~ Dynamometer

127.000 ft. lbs. in circuit
140.800 Dynamometer exclusive
magnetic ball friction
90.4 %

124.000
142.000

89 %

805
730
1.535
757

890
767
123

2.37
118
9.6 Ohms
1.25
10.85

2.7870
123 2.0899
4.8769

118 2.0719
9.6 .9823

~~1.0896~~
1.0896
1.93557
1.6464
4.8611
4.8769
.9842
96.4%

118 Volts

72.600 ft lbs. ~~gross~~ delivered 9.6
75.300 ~~dobinacl~~ given
96.4%

79.4000 ~~Belt~~ Current
82.600 Belt
96.2%

These ~~%~~ per cents are taken ~~not~~ ~~[illegible]~~ of the power given to the machine simply closing the armature circuit

2 | 9.1638
4.5919
3.4450
1.1469
1.1469
1.6464
.1553
4.0955 12.400
4.5185
.4230

9.3775
4.6887
3.4450
1.2437
1.2437
1.6464
.1553
4.2891

4.5185
4.2891
.2294

2° 8' | 8.5708
4.2854
3.4450
.8404
.8404
.8404
1.6817
3.4825
4.5185
1.0366 10.8

No. 2 Machine

505 revs 4.5185
3.6717
.9468

~~12 H.~~
105. Volts

2° 35'
43
3° 18'

8.7601
4.3800
2.4450
.9350 8.62 Webers
.9350
~~1.43~~ .1553
1.6464
3.6717

8.8 per H. P.

4700
~~1118~~ ft. lbs.

14 Webers
115 Volts

8° 4'
43
8° 47'

12.400 ft. lbs.
2.64 per H. P.
115 Volts

8° 57'
43
9° 40'

116 Volts

13° 5' 17 Webers
13° 48' 1.7 per H. P.

118 Volts

6.9 Webers
10.8 per H. P.

1° 25'
43
2° 8'

100 Volts

52

23 1.4150

9.4 .9731

.4419

.4419

1.4 .1461

1.6464

ft 2.6763 4 (474 ft

4.5315 118 ft. lbs

V.6

8

14.4 .9031

1.1584

$\bar{1}.7447$

$\bar{1}.7447$ 155

77

5

25

65

32 1.5051

9.4 .9731

.5320

Oct. 30

15' 96 Volts

43' to be added Dalt.

Oct. 31 114 Volts

6° 22'

~~2.7~~ 1.8 Webers 69 Volts

---

26 Volts

.55 Weber

---

21 Volts

3.4 Webers 77 Volts

2(98
49

49 1.6902
9.4 9731
.7171

2(130
50

50 1.6990
.9731
~~.7259~~
.7159

104
52

~~7.7160~~
1.7160
.9731
.7429

191

(128
64
8.9

1.8062
.9494
.8568

8.5939
~~.8568~~
~~.7371~~
8.5939
4.2969
.8568
.4401

.8568
.8568
1.4 .1461
1.6464 7925
3.5061

32004 5785
1.0124

5.2 Webers
93 Volts

92 Volts
5.2 Webers

20 revo.

5.5 Webers
95 Volts

2° 15'
102 Volts
~~9~~
7.2 Webers
10.3 per H.P.

(9.1772
4.5886
3.4450
1.1436 13.9
1.1436
1.7925
4.0797 12000
4.5315
.4518

102.5
4
4.08

3° 47'
(8.8078
4.4039
3.4450
.9589
.9589
1.7925
3.7103
4.5315
.8212

.6107
25.65 1.4090
2.0197

100 2
15 1.1761
.8239
15.7 1.1959
1.0198

2.8 per H. P.
8° 39' 13.9 Webers 120 Volts

118 Volts
around

115
around

Polarization

6.6 per H. P 710 Volts
9.1 Webers

3° 5' 107 Volts

4.08 Webers in circuit 102.5 Volts
104 Volts around 25 ohms

6.6 Webers in circuit 100
104 Volts around 15 ohms

98	1.9912
9.4	.9713
.7	1.0199
	1.0043
10.1	2.0242

95	1.9777
8.6	.9345
	1.0432

10.4 Webers

106 Volts — 98 Volts

around 9.4

---

105 Volts R = 6000 ohms — 95 Volts

11.0 Webers

8.6 Ohms

---

105 Volts R = 60 000 ohms — 93

875
913
1788
894

830
780
1610
805

894
805
89 M

3° 47' . on 7 M.

481

8.8194
4.4097
2.4450
.9647
.9647
1.7925
3.7199
4.5185
.7986

90.5 1.9566 90.5
7.3 .8633
8.75 1.0933
1.0933
8.05 0.9058
1.6464
4.7388

89 1.9494
2.7905
4.7399

910
110 2.0414
2.7905
48319

95 1.9777
2.7905
47682

9.2 Webers over Magnet
6.3 per H. P.

102 Volts
90.5
over 7.3

12.4 Weber

There may be trouble noticed a change in measuring resistance

4.7388 54.800
4.7399 54.950
.9989 99.7 %

Exclusive all friction

4.7388
.7682
.9706 93.4 %

Exclusive friction in bearings

4.7388
4.8319
.9079 80 %

520 : 755 :: 105

105 2.0212
755 2.8779
comp 520 7.2840 -10
2.1831

152 Volts

2 (8.77.94
4.3897
3.4450
9447

.9447
1.7925
3.6819
4.5185
8366

137 2.1367
7.3 8633

10 lbs to drive No. 2 machine

3.7905
6170 ft. lbs to drive?
the armature at 520 revs

No. 2 755 revs

3° 27'

8.8 Webers on magnet

6.8 for H. P.

321
160 Volts
R=6.000 Ohms
137 Volts on
7.3 ohms
130 Volts
over 5.7 Ohms

1° 57

145
117
over 5.7

680 184 revs
732
1412
706 power taken 200 ÷ D
100 volts

---

845 246 = D
890 123 volt
1735 E
867.5

---

665 200
738
1403
701 Rev power
867.5
~~338~~
166.5 lbs
161.5

5.7 Ohms

to drive 184
revs

865
920
1785
892

3' to high
1° 15' on field

---

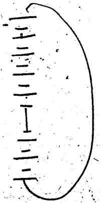
164 2.2148
2.7905
5.0053
101.000

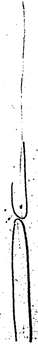
123 2.0899 2.
5.7 .7559 .7559
1.3340 1.2441
1.3340 1.2441
.8062 .8062
1.6464 1.6464
5.1266 4.9418
5.0053 5.0053
3 9365

86.4%

700
100
10000
7|443,000
33)221.500 (7

[illegible] in





100 830 725 revs
900
1730
865 running in magnet

346
1.73 Volts

δ 7° 43' on field

535 547
595 595
1130 1142
565 571

260
130 Volts

No 2 Machine running 725 revs 100

300 2.4771
2.7905
5.2676

185.000 ft lbs given the machine by the belt

---

130 2.1139
5.7 0.7559
1.3580

1.3580
6.4 .8062
1.6464
5.1686
5.2676
.9010

In the current 147.000 ft lb

80%

Very bad spark at the commutators.

.468
.234

.032
.013
047
6
.282

42
12
54

234

.224

~~250~~

M 1
.281
.120
.301
.602 ~~differ~~

No 2
350
.120
.470

940 : 602 :: 625
602
1250
3700
940) 371250 (3
2820
892

Machines Nos. 1 and 2 are wound with the same number of turns of wire. 468 in all. The wire in machine No. 1 was ~~made thinner~~ .032 inch in diameter that of machine No. 2 .042 inch. There was a distance from the core of No. 1 to the ~~armature~~ face ~~of the~~ magnet of $\frac{.468}{2}$, the same ~~for~~ in No. 2 was $\frac{.625}{2}$. It was ~~found~~ that when eight Webers were on the magnet of No. 2 the E.M.F. of armature was 104 Volts while in No. 1 it was 140 Volts.

If the proportion be made

Distance Coil in No. 1 from armature
: " " " No 2 " "
:: E.M.F. No. 1 : E.M.F. No. 2

it will be found to be nearly exact for the strengths of magnets nearing saturation

Dec 11 p 103–105

All this is wrong the measurements which Mr. K. gave me were not right

---

.940 No. 2 machine
.602 No. 1 machine Wrong

If as square

940 : 602 :: 122 : 78.1

.7796
.0864
0269
.8929

~~.7776~~
~~.0432~~
~~.0134~~
~~.8362~~

~~.3898~~
~~.0864~~
~~.0154~~
~~.4895~~

19731
.4865

.3898
.0864
.5135
.9897

If as square root

97.7 Volts

See page 30 where measure is . 81 No. 2

For example :

625 : 468 :: 140 : 106

106 instead of 104

6 Webers No 2. 9 Weber No. 1
97 Volts 128 Volts The ratio

No. 1 , 8 Webers No. 2 5.33 Webers
122 Volts ~~77.1~~ 92 Volts in place 93

No. 1, 7 Webers, No. 2, 4.67 Webers
114 Volts 86.4 Volts in place 90

No. 1 5 Webers No. 2 3.33 Webers
92 69.7 in place 81

These show that there is general ratio determined by this ratio of the distance of the iron as from [illegible] face of armature hold true!

Nov. 5, 1879

It is proposed to wind the No. 1 Machine with one layer of No. 20 wire. .035 in diameter

---

75 commutators Mr. Kruesies order book page 186 full particulars Order 180

168

.125
.0625
.03125
5
156

.03125
21
3125
6250
.676

3.67
3.17
.500

.033

3.17
3.141
Comp 54

.250
.231
.019

25 coils
2
54

3.141
3.17
21987
3141
9423

1 5/12)5.0(416

1.416

54)9.95697(~~.184~~
54
455
432
236

around core

7
.5

033)184(7
231

033
184
165
.019

033)184(6
148

50)9.956
1.99
165
34

4
6
48
38
48
30

169

Motor No. 2 Page 19

Iron core 3 in 5/32 3.17 Kreusi
~~Poles~~ Cunningham
Face to Face 3 21/32 3.67

16/32 1/2 in ~~1/4 in~~

1/4 inch between

.250

.500 Between diameter and
and bore of magnets.

1,416 feet once around
3.
~~42.48~~
27
8

42.4
25.
2120
848
1060.0 feet 22.6 Ohms

.22

Machine 20)15.6 Ohms
11.87
48
13.96
7.48
5.8 ohms

Motor No. 1

Bore in magnets 3.5 inches

Core 3.15

.350

25 commutators

6 layers
4 side by side
24 Wires in coil

35 : 50
7 : 10 :: 24 :
7)240(33.
21
20

Nov 10 Motor ran too fast with 80 Daniells 4 layers more on magnet.

~~Motor~~ Nov. 19

Tried condensers ~~at~~ on the commutator of the machine. connecting one side to the brush the the block above it No Effect.

Tried a battery in place of condenser no good. The spark could be taken off through the battery but there is no advantage in doing.

The neutral point can be found by taking a wire and making the ends on the commutator until little or no spark is seen. Half way between these points will be the place for the commutator brush.

Dec 8 Faradic Machine

No. 3, wound with layer of ·035 wire. Resistance ·16 Ohm 75 commutator block. Total difference between iron of core and the bore of magnets about 160 inch. At 750 revolutions with the magnet of such strength that machine No. 2 gave at 600 revs 120 Volts this machine gave 43 Volts where 110 were expected making it a total failure.

The faces of the magnets were apparently very weak as the iron of the armature was brought so near to them as to satisfy the free magnetism.

The ~~plain current~~ ~~cu~~ neutral point was found a little below the line drawn at right angles to magnets. This shows that the discharging time of a magnet depends on the amount of wire wound around it.

The magnet wire wound with three layers 1.7 ohms resistance.

If this machine had succeeded it would have been the grandest success known, as it is, it is only the same as the other machines. It would be useful for supplying a number of small arcs in multiple arc ~~arc~~ or for plating or for running magnets. Though nothing to boast of.

Ohms 2.22
.11
2.11

20 Volts over 2.11 Ohms

16° 16'
12 44
3° 32'

20 1.3010
2.11 0.3243
.9767

9.48 Webers

2 | 8.7897
4.3948
.9767
$\bar{2}$.4181

87 = D

29.

1.4624
.3243
1.1381

19° 42' 13.7 Weber
12° 44
6° 58

9.0838
4.5419
1.1381
$\bar{3}$.4038
$\bar{2}$.4181
$\bar{4}$.8219
$\bar{2}$.4109

Constant Dyne

120 Volts from No. 2 machine
almost no current on field.

51 Volts

1,1381
1,1381
1.6 .2041 13300
1.6464
4.1267
.5155
8

Each wire 1/4 as strong. Total E.M.F 1/4 X 1/2 as much as before 1/2 that before

---

Each layer 1/
.035
12
.047
4
.188
36
3)152
50

No 3 about .035 between outside of iron wire and face of magnet

.047
19
.057
2
.114

156
11.4
142
20

40

I still believe that an 1/8 of an ohm machine can be made to give at least 75 Volts.

In order to do this a solid iron core must be used and the wire be flat and all be made perfectly.

43 43)110(2.5
86
240
215
250

.150
.150

.156
2.5
780
312
.3900
.156
.234 in .150 field of core
60 inside of surface
17

No 2 Machine

101 Volts gave on lamp 123 Volts

20° (8.5428
4.2714
3.4109
.8605 7.25 Webers
.8605
1.6464
.2304
3.6078 4050
4.5785
.9707 8.1 per H.P.

Measurement No 1.

Thickness ~~of~~ wire .288

Between wire and face .120

.408

2

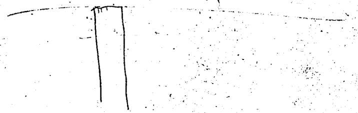
.816

No.

Measured the bore 9.22

The irons ~~faces~~ are 8.41
were

.81



Thickness ~~in wire~~ Bore 9.40

No 2 .94 8.46

.94

No. 3 .17 9.46

9.29

.17

No. 1 122 Volts Page 105.

No. 2

94 : 81 :: 122 : 105 in place of 93

$$\begin{array}{r} 81 \\ \hline 122 \\ 976 \\ \hline 94)\,9882\,(105 \text{ Volts} \\ 94 \\ \hline 482 \\ 470 \\ \hline 120 \end{array}$$

This seems to show that here the strength of the machine decreases faster than the distance of the face of the core from the face of the magnet.

Paris ~~light~~ Paris ~~light~~

94 : 17 :: 122
17

17) 94 (5.5
85
90

17) 65 (3.8
51
140
136
40

125) 65 (5.2
625
250

No. 3 machine space

$\frac{1}{5.5}$ that of No. 2

43 Volts in place of 120

43) 120 (2.8
86
340

$\frac{1}{2.8} \times \frac{6}{7.5} =$

2.8
7.5
140
196

6) 21.00 (3.5
18

No. 3 $\frac{1}{3.5}$ of E.M.F of No 2

$\frac{1}{3.8}$ of resistance of No. 2

No. 3 Machine

49
3
147
70
217

49
6
.294
.120
.414

120
70
.050

No 3 $\frac{1}{3.5}$ of E.M.F of No. 2

$\frac{1}{6}$ of layers of No. 2

39
2
78 turns around machine No. 2 39 coils

75 turns around machine No. 3

No. 3 Machine

Now 9.46 Face of magnets

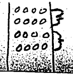
$$\begin{array}{r}.035\\3\\\hline .105\end{array}\qquad\begin{array}{r}.047\\3\\\hline .141\end{array}\qquad\begin{array}{r}9.46\\.16\\\hline 9.62\end{array}$$

Make the bore between the face of magnets 9.62

Make new vulcanite ends a little smaller than the present ones and having an arrangement like that first proposed for No. 3 with so that a steel sheet may be used to keep the coils apart

Wind with .035 wire

4 layers



4 wires

side by side connected in eights.

.7

1.4 $\frac{33000}{20}$ = 33000

10

7 | 10 (1.4   4000

1.4 $\frac{33000}{2.0}$ per H.P

1.4

Make No. 4

9.62 inches from face of magnets

3 / 189
63

63

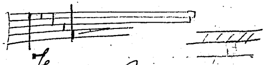
.042
.013
.055

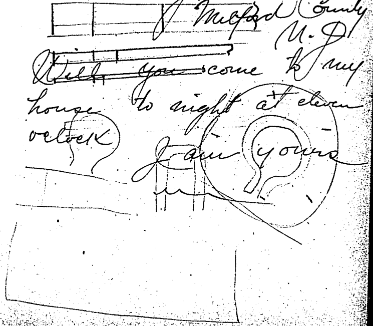
.055
4
.220
4
10
.270
2
.540

9.62
.54
9.08

035
.13
.048
3
144

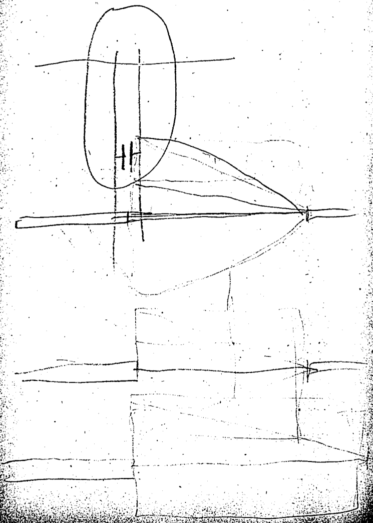
9.46
[illegible]
.604





Francis Jackson
Milford County
N.J.
~~Will you~~ come to my
house to night at eleven
oclock
I am yours

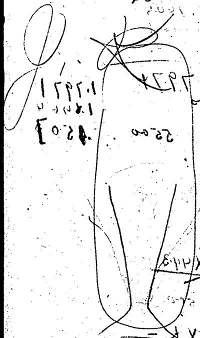
128



No 4 9.62

9.05

962



129

220
224
12
12
20
20
544
22
224
224
12

56
24
224

420
40
550

905

1.4 Ohms

$6\overline{)33.000}$ ft. lbs.

5.500 ft. lbs.

5500 3.7404

1.4 0.1461

$2\overline{)3.5943}$

1.7971

~~6.27~~ Webers

1.7971

1.6464

.1507

~~3.5228~~ 5 5500

~~1.7971~~

~~5.3199~~

~~$\frac{R \times 44.3}{\varepsilon^2} = 6500$~~

~~$\varepsilon^2 = \frac{R \times 44.3}{}$~~

$\frac{\varepsilon^2 \times 44.3}{R} = 5500$

$\varepsilon^2 = \frac{5500 \times R}{44.3}$

$c^2 R \times 44.3 = 5500$

$c = \sqrt{\frac{5500}{R \times 44.3}}$

3.5943

1.6464

$2\overline{)1.9479}$

.9739

9.4 Webers

3.5228

.9739

4.4967

2

8.9934

3 5228

2

7.0456

5° 39′ 4′

~~3.5~~ $c = \sqrt{\sin D}$

$\sin D = c^2$ $\sin D' = c'^2$

$\sin D' = \frac{c'^2}{c^2} \sin D$

10.0000

7.0456

$2\overline{)2.9544}$

1.4772

30 Webers

limit

Calculation for wire to hold the Cu. wire to cylinder of armature

Centrifugal force formula

Molesworth

F = .00034 WRN²

W = 1 lb

R = 20/2 inches = 5/6 = .833

N = 600 revo

600

360000

.00034

144

108

122.40000

.83

366

976

F = 101.26 lbs

6|500

166

833

Cu wire .042 inch diameter

Cross section .001385

150 divisions

12

300

150

1800 wires

9 inches long

16200

.001385

16200

277000

8310

1385

22.437000 cu inches

.32

448

672

7.168 lbs

Covering 1

8.168 lbs

101

816

816

824.16

F = 824 lbs

Place steel wire ~~every~~
inch 9 on armature

9 | 824
91 lbs to bunch wires

---

10 wires .010 inches

3.14
.000025
1570
628
.0000785
10
.000785 sq inches

Cross section
Tensile strength
52 tons sq. inch

2240
52
4480
11200
116480
.000785
583400
931840
821360
92037800

Tensile strength 92 lbs

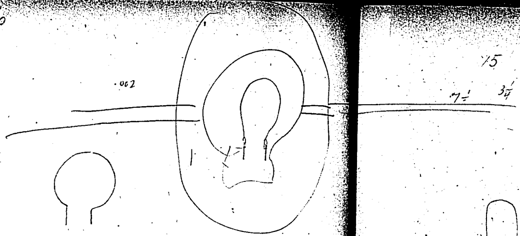
.14 Ohm

6 wires
4
24
6
144

.14
24
46
28
3.26
.6
19.56 ~~lbs~~ Ohms

about 9 lbs of wire reckoning from resistance ~~for as the wire is smaller~~ for the 1/2 covering the cylinder. Since the wire guages. Ohms in a lb

109) 1956 (18 lbs
109
876
872
4



very Truly

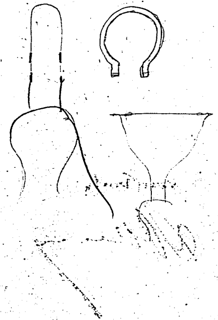
15

9

2¼

9½

4



Plates 271
Cut 268 1 ohm out 260
2 ohms

Sq wire 260
280 after shunts on other

7 ohms

The ~~machines~~ armature with square iron wire wound with two turns four layer .042 wire: 86.6 Volts when with same current on field magnet the machine with 1/8" plates gave 90.3 Volts and round wire iron armature 92 Volts

1050 revs 7 ohms regulator

52 Volts on 7.22 Ohm
Mark 7 ohms at regulator.
7.2 Webers on field

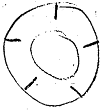
7.22) 52.00 (7.2
50 54
1460

7.2
7.2
14 4
50 4
51.84
44.3
155 52
20736
20736
2306.5 1.2
1.4 first 1.6
1383906 .2
230651
3690.4 1.6
461302
3229.1 14
3229 ft. lbs
10.2 per H. P this shows that the fields are weak

3229) 33.000 (10.2
3229
7100

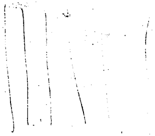
3690) 33000 (8.9 per H.P.
~~[illegible]~~
~~[illegible]~~
29520
3.4800

140 Armature. Two inches of plates ·1640 inches thick cut



240

after 15 minutes 50°C
Rise 26°C



19

Test of wire
for 5 ton order
Diameter .124 in
.125
.125
.124
.125
.126
.128
.125.5
.125
.125
.126
.125
.127
.125.5
.127
.122.5
.124
.126

18) 6·35 (52
90
35

.125 2

80 feet

9.83 Ohms

80

15625) 78.640 (50

78225

4~~7~~50

18.3 C

5) 26

52

9

468

32

78.87

7.3 °C Rise of box

9.71 Annealed Cu.

.00031

7.3

93

217

.00226~~3~~

.05

.0001130

5

.0501

9.71

.75

4855

6797

15625) 72825 (466

~~300~~

62500

103250

93745

95050

A wire of pure Cu anneal
75 feet long at 0°C has
a resistance of .0466 Ohms

26° C

.00382
26
2292
764
.09932
.00685
.100187

.26
.26
156
52
676
.00000126
4056
1352
676
.000085176

0466
466
at 26°c .05113 Ohms

The Cu wire to be tested
had a resistance of .05 Ohms

24
24
96
48
576
.00000126
4456
1152
576
.00073576

.0466
.0924
1864
932
4194
.004305844
.4668
.05096 Ohms

00382
24
1528
764
.091 68
.00073
.0924

.0466
.917
3262
466
4194
.04273 22
466
.508

.0509

.0501) .0509 (101.4 %
.0501
800
501
2090

Mr K

.127
.125
.126
.127
124
124
125
125
126
127
124
124
125
125
126

80
126
124
17/190 (53
85
50

75 feet 3½ inches

wire .1253 inches diameter

foot grain 24°C
.2328 Ohm

3 Weight 3 lbs 10 3/8 oz
48
10.37
58.37 oz of wire

5760
175
28800
40380
5760
144) 1008600 (7004
1008
600

7004 grains in lb Adv

16) 7004 (450.2 grains in oz
64
80
80
400

```
   58.37
     450        foot grain  .2328
 ---------                    75.3
  291850                   -------
 23348                        6984
------------                 11640
26 266.50                   16296
                           -------
                           17.52984
                            7.5378
                           -------
                             5356
                             8760
                            12264
                                          Ohm
262666.50 ) 1319.3556 ( 50.2
            1313.325
            ---------
               603100
```

.0502 Ohms by weight

.0509 " " size

.05 [illegible] " actual

Mr Edison

Average Diameter .1252 inch
Wire slightly oval in
form and varied from
.124 to .127 in. in diam.

75 feet 3 inches gave at
24°C a resistance of .05 Ohms
and weighed 3 lbs. 10 3/8 oz.
Comparing with Matthiessen's
table given in Jenkin's
page the wire is
100.5% by weight
102% by size

JI

Method for testing wire

First carefully measure the resistance of a length such that it ~~aisble~~ can be easily laid on the laboratory floor. and with a strong battery on the bridge make ~~AB~~ the resistance an even number of ~~Ohms~~ $\frac{1}{100}$, $\frac{1}{10}$ or 1 Ohms. by putting in more or less wire, call ~~R~~ r'. Then lay the wire straight on the floor and carefully measure its length.

Note the temperature of the floor and air of the room.

The correction for the box will be .00031 for each degree ~~C~~ Centigrade above 18°3.

$R' = r'(1 + .00031t)$

R' = ~~Line~~ resistance corrected

r' = measured "

Guage carefully the diameter of the wire at regular intervals along its whole length.

The resistance of pure copper may be found from these data. As all copper wire is annealed which is used for electrical conductivity that may be taken as standard.

Jenkin page 251 gives the resistance at ~~for~~ 0°C of a wire one foot long $\frac{1}{1000}$ inch in diameter as 9.718 Ohms on the authority of Matthiessen.

For any other length or size of wire the resistance at 0°C may be found from the formula

$$r = \frac{9.718}{d^2} l$$

d = diamter wire $\frac{1}{1000}$ inches
l = length " feet

For other temperatures the formula ~~gives~~

$$R = r(1 + .003824 t + .00000126 t^2)$$

gives the true resistance
r = resistance at 0°C
t = temperature Centigrade

R : R' :: 100 : x

$100 \frac{R}{R'}$ = per cent of conductivity of the wire to be tested

---

2^end^ method by weight

Weigh the wire reduce to grains call it W. [illegible]
7000 grains = 1 lb. adv.

16)7000(450 grains = 1 oz. adv.
64
80
80

[illegible] Measure the length off as before of an even number of decimal parts of an Ohm denominate it L

~~other~~

The resistance of an annealed wire at 0°C one foot long weighing one grain Jenkin page 251 is .2064 Ohms

Correct this for temperature according to the formula given also correct the measured resistance for the change in the box as given designate as R'

15 ✓ The resistance of pure Cu is ~~R~~ a pure copper wire of equal length and weight can be found from the equation

$$R = \frac{.2064\,(1 + at + bt^2)}{\frac{w}{l}}\,l$$

Then $R = .2064\,(1 + a\,t + bt^2)\,\frac{l^2}{w}$

$100\,\frac{R}{R'} =$ Conductivity per cent

To change the formula $R = r\,(1 + a_c t_c + b_c t_c^2)$ from Centigrade to Fahr. $t_f =$ temp $- 32°$

$$a_c t_c = a_f t_f$$

$$a_f = a_c \frac{t_c}{t_f} = \frac{5}{9} a_c$$

$$b_c t_c^2 = b_f t_f^2$$

$$b_f = b_c \frac{t_c^2}{t_f^2} = \frac{25}{81} b_c$$

$a_c = .00382$

$a_f = .002120$

$b_c = .00000126$

$b_f = .00000039$

Fahrenheit

$$R = r\,(1 + \overset{.00212}{\cancel{.0000126}}\,t + .00000039\,t^2)$$

$9\,)\,.00382$
~~.000424~~
.000424
5
$.002\cancel{1}20$

$81\,)\,126\,(\,15.5$
81
450
405
45

15.5
25
775
310
3875

[redacted]

20 inches
1 ft 8 inches
1.66 feet
.83 feet

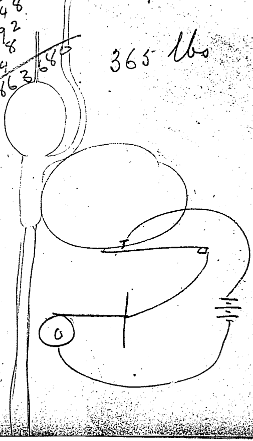
60034

52 tons

2240
52
4480
11200
116480
.003141
116480
465920
116480
349440
365.863680

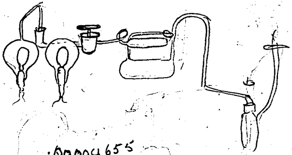
.020
3
.0003141
.003141

365 lbs



.00004655

.0254
25.4 mm



.00004655

162

×245	117
265	117
270	117
285	119

310	122 132
×300	132
300	127
240	12-6
300	

×

270	132
235	128
—	121

	142
225	142
240	147
270	145
250	145
270	138
275	145
×300	

×320	139
415	145
415	147
260	147
240	135
250	136
247	147
250	142
235	135
245	145
240	142
270	149
250	135
230	134

×275	160
370	163
300	197
×275	230
×240	199
285	167
250	195
250	180
225	160

163

Old Lot

×295	157
×300	150
×340	150
300	157
275	153
255	150
265	157
265	157
245	155
245	152
275	155

21 of 143.
11 of 153
8 of 128
4 of 117
9 [illegible] 185.

Testing

Loss on machine = loss on armature
friction
magnet

~~Hor .7 H.P~~
7 H.P consumed outside 10:1
.7 inside

Run machine at 1250 revs
The higher the speed the better showing. The amount consumed on the magnets remains the same, the friction in the bearings increases proportionally while the magnetic and converting power increase as the square of the speed.

Find form of Prony from Appleton

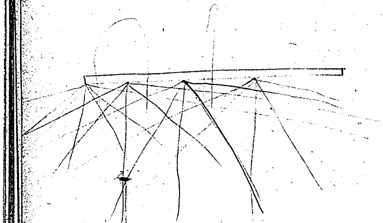
Figure out Elec. Connections and method of measuring resistance when hot.

Prepare condenser
electrometer
high resistance

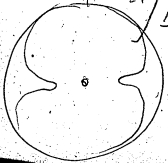
Test fibre lamps

Test scale to see if all right

164 Test resistance box



Photometer



21)150600(7171.
147
36
21
150
147
30

1250 Revs

165

Friction	7.000
Magnetic Friction	4.000
Commutator	1.000
Outofbalance	1.000
Magnets	3.300
	16.300

20 to 1

Resistance machine .14 Ohm
20
2.8 outside
.14
Total 2.94 Ohms

E. M. F 100 Volts.

100
~~440000~~
294) 443000
294
1490
1476
~~314~~
2000

(150600

33)130600(4

Wire on armature 7171

150600) 16.300.00 (108
150600
~~274600~~
1240000

89.2 % Converted

16300
7171
150600) 23471,0 (85.6
150600
841100
753000
881000

84.4 % Outside

84.4
9.4
3376
7596
7.9336

96 % Exclusive friction

6000

Winding machine for 1250 rev

Each wire $\frac{5}{4}$ as strong

$\frac{8}{10}$ the number of ~~coils~~ turns to give the same E. M. F.

$\frac{8}{5}$ the number of coils to 8 of one turn each

each coil $\frac{5}{8}$ the ~~wire~~ present width

000 $\frac{5}{8}=\frac{15}{24}$ $\frac{2}{3}=\frac{16}{24}$

$$\frac{5}{8}=\frac{45}{72}=\frac{15}{24}\frac{6}{9}=\cancel{\frac{54}{72}}\ \frac{48}{72}\ \cancel{\frac{16}{24}}\ \frac{2}{3}=\frac{16}{24}$$

$75\times\frac{8}{5}=$ ~~200~~ 120 coils

118

Resistance each turn

$$\frac{3}{2}\times\frac{1}{4}=\frac{3}{8}$$

$\frac{8}{5}\times\frac{3}{8}$ = Resistance machine

$\frac{3}{5}$ the resistance of the other

$\frac{3}{5}\times .14=\frac{.42}{5}=$ ~~.08~~ .084 Ohms

~~[illegible]~~

If the two layers can be ~~put further of~~ have double the wire in them the machine will have .07 Ohm $\frac{1}{2}$ present machine

Armature 1014 Plates
.001 Tissue paper

see page 217

Four thicknesses of cloth

28° C Warm from previous Ex.

after 45m 36° C 8° Rise

1h45 43 7° 15°

8 hours 52 C

Cover taken off 4 A.M

after ~~5'30 A.M~~ 42°

8 A.M 37°

Round wire

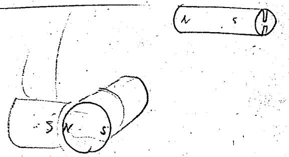
old machine 4 layer cloth

10 24° C

10-50 60° C

11-50 72° C

Axle cool



10 lamps 9 per H. P.
100 Ohms each

9 Ohms total

.15)9

Thin plate .014
Tissue .051

Pages 217 tests
178

Dimensions

Magnets

bore 9.75

Armature space between flanges 8 inches
Length over all 8.375
Weight Total — 107 lbs
Less wooden core and axle ~~and [illegible]~~ 26
81
No. plates 524

Diam core woden 6.25
Diam iron 9.18

34
34
136
102
1156

117
117
819
117
117
13689

Photo

1156) 13689 (11
1156
2129
1156
973

3

118
118
944
118
118
13924

331
33
99
99
1089

1089) 13924 (12
1089
3030

Photo

3 / 118

49.7
50.55
52

33
33
99
99
1089

118
118
944
118
118
13924

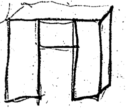
1089) 13924 (12 85/
1089
3034
2178
856

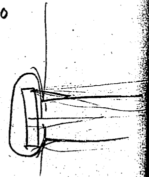
180

28
28
224
56
784

122
122
244
244
122
14884

784)14884 (18.9 candles
784
7044
6272
7720





181

195)605 (31
585
200
195

3.1
3.1
3.1
93
9.4.1
2
18.8

64.7

15.3)64.7(4.23
612
350
306
460

4.23
4.23
9

60 3/8

61 1/8

Tissue paper for screen total failure

61.1
18.9) 61.1 (3.23
567
440
378
620

3.23
3.23
969
646
969
10433

20.8

605
195) 605 (3.1
585
200
195

3.1
3.1
31
93
961
1931

57.6
22.4) 57.6 (2.57
448
1280
1120
1600

2.57
2.57
1799
1285
414
56049
2
11.2

47.3
32.7) 47.3 (1.4
327
1460
~~988~~
9

1.4
1.4
56
14
1.96
2
3.92

18.7
41.3) 18.70 (.45
1652
2180

.45
.45
225
180
.2025

60.35
196.5) 6035 (30
5895
1400

65.2
14.8) 652 (44
592
600

44
44
176
176
19.36

63.6
164) 63.6 (39
492
1440

39
39
351
117
1521

59.9
201) 599 (298
402
1970
1809
161

591
209) 591 (283
418
1730
1672
680

283
283
849
2264
56.6
80089

56.6
234) 56.6 (242
468
980
936
44

2.42
2.42
484
968
484
58564
2
11.9

2 7 0
2)8)5

~~Three~~ One machine an 90 volts

~~11.8~~ candles 49.7 / 303

20.3)49.7(244
406
910
812
98

244 × 244 = 976, 976, 488, 59536

5.9 × 2 = 11.8

Three machines 90 Volts

2.6 × 2.6 = 156, 52, 676

candles 50.55 / 29.45

29.45)50.55(2.0
38.90

One machine 90 Volts

52 / 28

28)52(29
36
160

2.9 × 2.9 = 261, 58, 841

Three machines 90 Volts

5.2
50.45

One machine 90 Volts
49.8

~~So~~
49.7

303)49.7(1,64
303
1940
1818
1220

164
1.64
656
984
164
26896
2

Candles 5.36

29.4)50.5(1
294

28)52(1
28
240

15

1200

33000
8
264000

110
110
12100
44.3
36300
484
484
536030.0

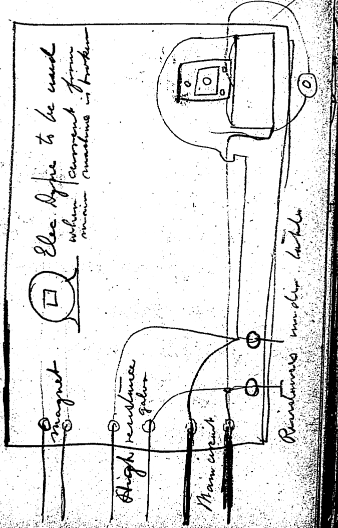
264) 536 (2 Ohms Total
for 8 ~~horse power~~

1.75 Ohm

3 Ohm boxes

½ boxes side by side

Under tables resistances



Elec. Dynamo to be used when current from main machine is broken

magnet
High resistance galvo
Main circuit
Resistances under table

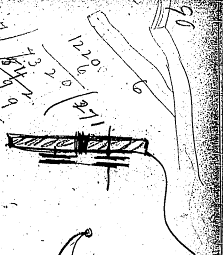
12200
6
73200 (271
27) 73
54
192
189
30
27
3

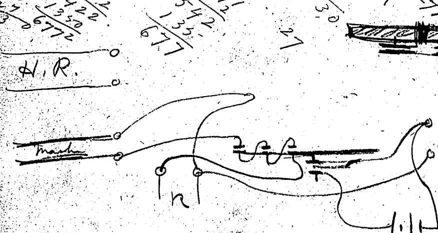
271½
2
542
135
677

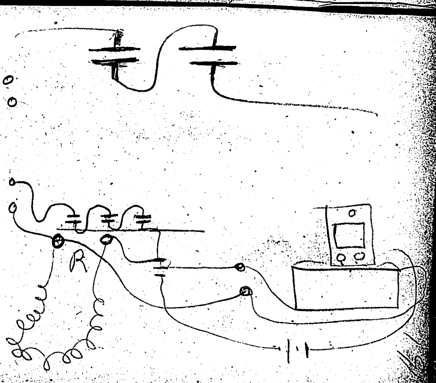
27) 2711

12200
6
27) 73200 (2711
54
192
189
30
27
3

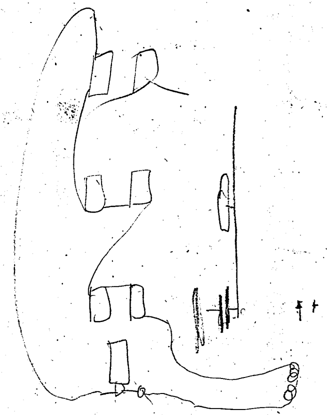
2711
2
5422
1355
6777

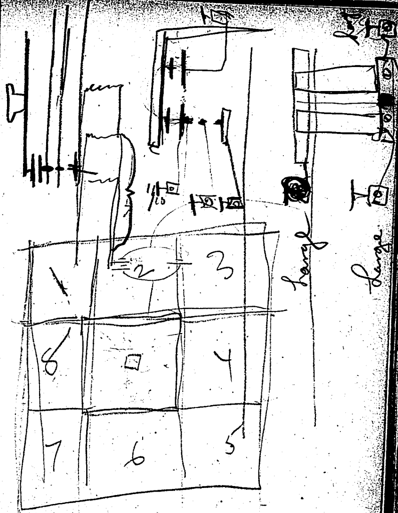


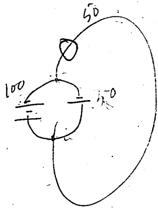


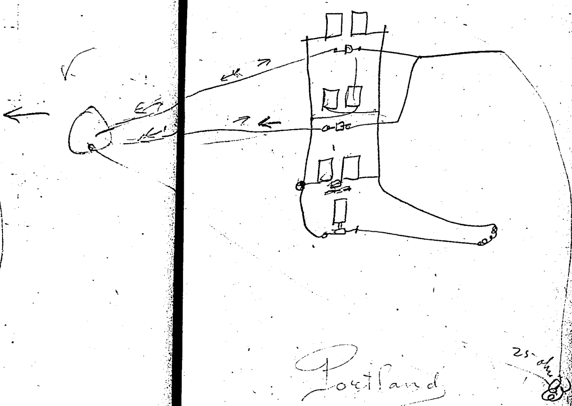


H. R.
machine
R




Large
Large





Portland

196

7 | 45.-
6.4
6.4
57.8

750,
75
562

850,

850
850
42500
680
722500

750,

$\frac{56}{72}$ $\frac{28}{36}$ = $\frac{14}{18}$

$\frac{7}{9}$

6.00,

64

170
150

170
150
8500
170
25500

156
65
780
936
93601
10.14

36
4
144

144

197

90, 28, 32,

20,

10 | 132. | 13
10
32

156, 1 = 10
4

15.000

65 .8 8.

65.

65 lights

156
8
1248

10.9 Webers

1.2) 13.1 ~~[illegible] Webers~~

12

1.10

108

20

7° 35

9.2.04

4.5602

1.0374

3.5228

Constant dyne

7° 35'

13.[illegible] Volts over 1.2 Ohms

1

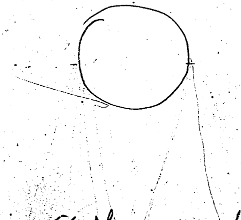
200 11-20 P.M Feb 4.

The armature, of plates un-painted run free with a covering of cloth in a field such as makes 85 Volts with 40 lights on a .14 ohm machine
88 lbs of Iron

11-20 Temp. 24°C
11-35 37°C

Started
11-42
12-12 53°C
24
29
12-18
12-48 59°C
24
35
12-53 68°C
24
44
1-37

Started 1-34 A.M 201
2-04 69°C
24
45
Cooling
2.30 64°C
5 am. 40°C

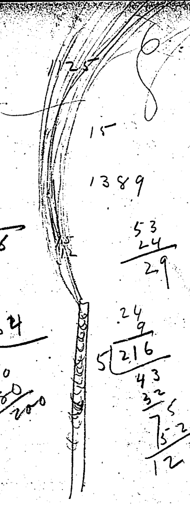


Machine .54 ohm round iron wire supplying 24 lights
55°C

772
9
5)6948
1389
881
1389
5

1389
.12
2778
1389
166.68
166.
80
00

45)290(.64
270
200
180
200



1/25

15

1389

53
24
29

.24
9
5)216
43
32
5
7
5.2
127

29
9
.26 1
52 1/3

70

1389
.12
166.68
80
13.334.40

1/25 1/3.5 2/7

1/3 Horse Power

---

10 lamps

~~1~~ H.P 3 Volts

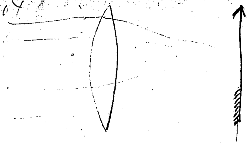
30

3.96 Foot pounds per minute

166.68
.88
13.3334
13333
14.666.7

14.666
.64
58664
87996
9.387 2.4

9380)33000(3.5
28
5000



.27

Feb.

Armature with painted plates

~~2-42 A.M~~	22° C	
2-42 A.M.	38° C	25 m
3-7 A.M.	22 16	
3-13 A.M.		
3-33 A.M.	47° C 22 25	

six minutes

3-40 A.M.	60° C
4-10 A.M.	22 38
4-17	68° C
4-47	22 46
4:53	70° C
5-08	

5-15

5-30 71° C
22
49

Comparison Increase

	Without paint		With paint
Face	22° beginning		faces warmer end 32° C
1/4 hours	(1) 13°	25 minutes 15 " (2)	16° 9.6 25°
3/4 hours	29°		
1 1/4	35°		38°
1 3/4	44		46°
2 1/4	45°		49°
after 12 hours	~~87~~°		87° 24 63°

25 : 15 :: 16
16
90
15
25) 240 (9.6
225
15

The ~~first~~ fifteen minutes would seem to give fairest test and that shows that the painted as against unpainted there is a gain of 33%

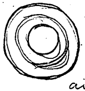
88 lbs cast iron
.12
176
88
10.56 thermal units

1.8 772
1.8
6176
772
1389.6
105
6945
1389
145845

14585) 33000 (2.27
29170
38300
~~37555~~
29170
91300

$\frac{1}{2.27}$ H.P = .440 H.P.

Feb. 9, 1880



Split rings with air spaces and cups placed on the outside to force air in

10-6 P.M. 30°C 15 minutes
10 21 63.5°C 33°.5

10-28 P.M. 1/2 hour
10-43 75° C 45°

10-50 P.M. 3/4 hour
11-5 89° 59°

11-7 1 hour 1/4
11-37 100° 70°

11-42 P.M 1 hour 1/2 73°
11-57 103° C

10
4
5
19

12-3 1034

N.S.

The plates probably connected by means of the ~~#~~ bolts connecting and the wires separating them so as to form a short circuit ~~for~~ to the current generated in the armatures. The outside ring also probably acted as a shield ~~to~~ the inside and received nearly the full force of the currents induced and showed the heat very

Armature made of iron plates .037 inch thick bolted together with brass rods insulated from the ends. Large iron plates on ends insulated. Plates very much oxydized Mr. K says 1/3 oxide. 186 plates

9-48 P.M	25° C	15 minutes
10- 3	30° C	5
10-11		30 min
10-26	36°	11
10-36	40°	45 min
10-51		15
10-59	46°	1 hour 15
11-30		21
11-41	55°	2.15
12-41		30

186) 9.00 (48 Measure from iron inside .048 each
744
1560
~~62~~

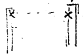
12-50	61°
1-50	

Summary

15 minutes	5
30	11
45	15
1 hour 15 minutes	21
2 hours ~~1~~15	30
3 hours 15	36

Mr. K .037 plates

Please count and weigh the plates on both ~~machines~~ armature thick and ~~thin~~ Measure also ends the distance from insides of outside thick iron plates from each other



Paint the thin plates

Devise some means so that there can be no metallic contact between any of the plates, that is so that each one will be insulated from each other. The brass rod running through them is bad I think. TAE

Feb. 14 1880

Mr 21. a .037 plates

198 rings Total 85 lbs

average thickness .038

Weight thin rings 71 lbs

" thick Disks 14 "

Distance between Disks 8 in

Thickness of two Disks 8.83"

Thick plates armature same space weighs 75 lbs. (74.14) discs on ends 14 lbs

Total 89 lbs

.037 plates

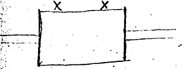
According to weight of metal the thin plates should give

89 : 85 :: 100 :

89)8500(95 Volts
801
490
445

1/2 the heating on the thin plates

Feb. 14, 1880. The thin plates were painted and put together.



The resistance from x to x was .08 Ohm

Tissue paper placed between each plate. R = .36 Ohm x to x

The burrs from cutting the plates were carefully filed away so that there was no connection through

them in each of these experiments .037 plates

		Rise	
2.00 P.M.	24° C	~~24°C~~	
2-15 P. M	29° C	5°	5°
my watch		.45 minutes	
2-17	35.5 C	6°5	11.5
2-47			
		1 45 minutes	
2-59			
3.50	41°	5°5	17°

The machine .014 plates to be

.014 in plates   march –
.001 Tissue   Lined with the [illegible] cover

24°
26° after 1.5 minutes   Rise 2°
32° " 45 / 1.45   " 6° 8°
36°   4° 12°

1/14 H.P.

See page 174 for test with cloth

5°C. Rise of 85 lbs of iron

1°C rise 1 lb of H_2O = 1389 ft lbs

5° in 15 minutes

1/3° – 1 minute

$$\begin{array}{r} 1389 \\ 10.2 \\ \hline 2778 \\ 1389 \\ \hline 14167.8 \end{array} \text{ ft lbs.} \qquad \begin{array}{r} 85 \\ .12 \\ \hline 170 \\ 85 \\ \hline 10.20 \end{array}$$

$$\begin{array}{l} 14.167 \,)\, 33,000 \,(\, 2.33 \\ 28334 \\ \hline 46680 \\ 423 \\ \hline 438 \end{array}$$

4.722

$\frac{1}{2.33}$ H.P. for 1°C

$\frac{1}{6.99} = \frac{1}{7}$ H.P. for 1/3°C

~~0~~ = .143 H.P.

$$3 \,\big|\, \underline{14167}$$
4722 ft lbs

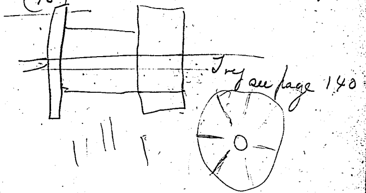
Suppose 100 Volts E.M.F.

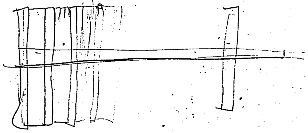
~~150~~ 75 coils each 2 turns

$$\begin{array}{r} 2 \\ \hline 150 \end{array}$$

2/3 Volt = E.M.F of one turn

$(2/3)^2$





Thick plates with three Layers of tissue paper between each of them the same as tried page 206. 1000 Revs. Magnet the same as in practice

15 minutes

4-50 P.M. 23° C

5-05 34° C 11°

45 minutes

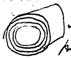
5-13 P.M. 49° C 15° 26°

5-43

Five brass plates 1½" diameter lacquered and clamped together resistance of all ½ Ohms

---

Armature made of long strip of iron .032 inches thick wound in the form of a spiral. Weighs lbs.



The ends were insulated by two thicknesses of paper and placed between the iron plates and the iron and tracing linen pasted on the iron plates. The strips were wound with five thicknesses of paper between them.

Seven Ohms in + Three fields

1.4
3
4.2
.9
5.1
7
12.1 Ohms

9-23 26°

9-32 Smoking! 86° 60°

9|60°
6.6

14163..
66
88976
88976
33 | 97873.6 | 3 H.P. about

7.2 Webers in field

~~Mr. Edison wants the armature with the spiral rewound. The paper insulation between the strip should be 1/8 longer than the iron. The edges and rough spots in the iron to be smoothed. Every precaution to be taken to insure perfect insulation for much work.~~

Suppose short circuiting	1/10 H.P.	3300
Armature	1/10	3300
Friction		7000
Commutator friction Magnetic and material friction		2000
		15 600
Field magnet 1/6		5500
		21.100

50 lights .14 Ohm. machines

14)200 (14.3) 165
14
60
56
40

165
13) 165000 (12670
13
35
26
90
78
120

6 H.P. = 198.000
21.100

50 lamps 3300 each — ft lbs 165000
Wire in machine — 12,670
Short circuiting &c — 21,100

33 770

50) 198,770
3,975

3,975) 33000 (8.3
31800
1.2000

8.3 Net

Conductors

~~198.770~~
16 500
198770
50) 215.270
43054

4305) 33000 (7.6
30135
28650

# Shafting Engine
from Indication to belt

215 270
21 527
56) 236797
4735

4735) 33000 (6.9 per H.P. Net
28510
44900

Inclusive friction
91.2 %

Converts
165.000 Lamps
12.670 Wire in machine
177,670

177670) 15600.~~088~~8 % .088
141366
146400
141366
56400 81.8 %

50) 200 (04

14) 88 (6.2
84
40
28

.088

12,670
7000
165.000) 5.670.000 (804
~~5000~~
~~648 000~~

12670
7000
165000) 567000 (03
555000
120

97 % Exclusive friction

This shows 7 net from 10 in the current, from the indicated horse power of the engine or 8 net ~~if~~ from the belt

.14 Ohm Machine

125
1.4
500
125
1.750 0

.175 Ohms Machine at 85°C

---

10 Lamps 100 Ohms each

1/10 H.P on each

1 H.P. 10 Ohms outside

$\frac{.14}{10.\cancel{14}}$ X 1 H.P. on machine

33000
.014
132000
33000
462.000 ft. lbs. per minute

1°C rise in ~~ar~~ armature

page 218

14,167 ft. lbs.

9 lbs of Cu

.095
9
.855

1389
.855
6945
6945
11112
ftlbs. 1187.595

Total 14.167
1.187
15354 ft. lbs. 1°C

Page 207

16° in 25 minutes

25)160(.64° per minute
150
100

14167
.64
56668
85002
9006.88 ft lbs per minute

9066 ft. lbs. per minute to hold
the armature at [illegible]°C
63° above air

9066 : 462 :: 63 :

87
3734
3596
9066) 40194

462
63
1386
2772
9066) 29106 (3.01
2898
1 2600

3°.01 rise for 10 lamps

---

20 lamps
12° rise

462
4
1848 ft lbs.

---

40 lamps
48° rise

7392 ft. lbs.

$\frac{100}{40}$ = 2.5 Ohms

Machine hotter say .15 Ohm

.15) 2.5 (16.6 to 1 Ratio
1.5
100
90
100

---

56 lamps
.17 Ohm

1.7) 100 (58 Lamps
85
150

5.8 H.P. consumed lamps
.58 " " Machine

33000
.58
264000
165000
19140 00 ft lbs on machine

9066 : 19140 :: 63
63
57420
114840
9066) 1205820 (131°C Rise?
9066
29920

This results is not true
since the .56 Ohm machine
will run 30 lights and not
grow very warm nothing
like 130° C above the air

Experiment to ~~try~~
30 light
30)100 (3.33 Ohms
~~On external circuit and~~
run the machine 87.4 Volt

/

63)9066 (144 ft lbs
63
276
252
246

144 ft. lbs. per degree C.
loss per minute

~~Machine~~ Armature wound half full with square wire insulated in layers from each other like Ritchie coil

24° after 15 minutes 60°

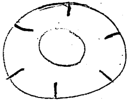
Rise 36°

1.5 minutes more

Rise 56°

The solder could not be taken off from the outside

See page 140 for test



Solid iron armature 10½" long
1½" thick

83
26
57°C in 13 minutes

87° in 13

13 : 15 :: 57° :

13)57.2(4.4
52
52

The armature with .037 in plates ran 75 lights with an E.M.F of $\frac{285}{3} = 95$ Volts for three hours and heated to 100°C. This is the beat ever done in the world and brings us home with this size of machine

---

''

Test of copper wire

Three feet of wire weighs 1100. grains

Covering weighs 33.3 grains

Covering 3% in weight of whole

.06 Ohms at 19.5°C below the coils

20.5°C at the top of the coils

20° average

101 feet 2 inches of wire

$$1100\overline{)33.30}(3003$$

$$\underline{33}$$

$$3000$$

Diameter of wire
about ten feet apart

Inches .132
.1325
.132
.132
.1325
.132
.132
.133
.132

20

Average .1322 inches

Five feet of wire weighs 1845.5 grai

" " " " " 1839.7

" " " " " 18375

Fifteen feet of wire 3 | 5522.7
1840.9

Covering weigh 168.5 grains

55227)168.500(3.05 %
165681
291900

.05 % for covering.

$$r = \frac{9.718}{d^2} l$$

d = 1322
d² = ~~425664~~
17476.
l = 110.16.

1322
1322
2644
2644
3966
4256.84
1322
17476.

42556)9.718(.002283
~~8513~~
~~12060~~
~~8512~~
~~35480~~
~~34048~~
14320

.002283
.032

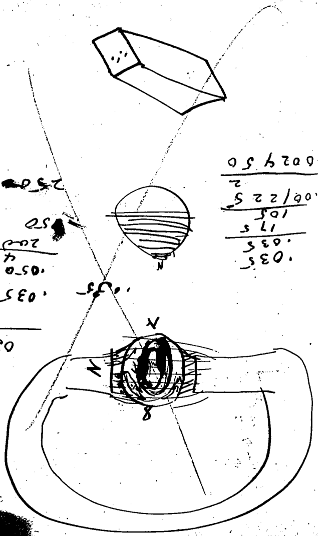
~~5319.016~~
~~.002283~~
~~...648~~
~~...28~~
~~...32~~
~~...0~~
~~.032~~

17476)97180(.0005560
110.1632
87380
98000
87380
106200
104856
13440

55227
1685
5691.2

)168.50(.0296
11382
54680
51219
34610

2.96 % of ~~total~~ is in the covering.



.035
.035
175
105
.001225
2
.002450

.035

035
4
1

.035

.050
4
200

250

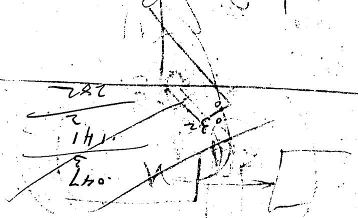
150

110.16
.000556~~0~~
~~44064~~
66096
55080
5508
.061248964

~~.0612~~ Ohms

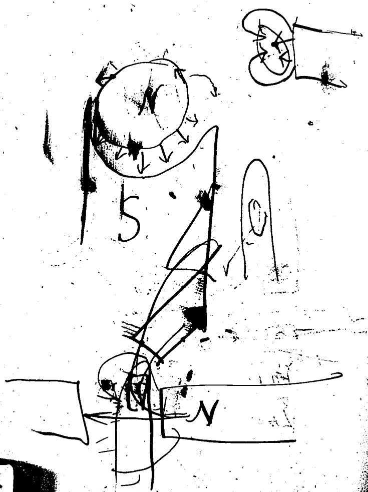
.0612~~5~~ Ohms = r

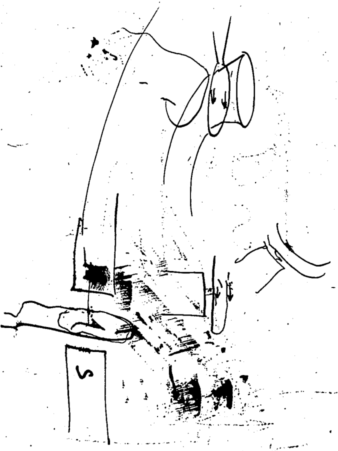
See page 240



.047
3
.141
2
.282

.032


N
S
N


S

$R = r(1 + .003824t + .00000126t^2)$

.003824
20
.076480

r = .06125

.06125
38240
15296
7648
45888
.0046843 006
.06125
.06593

20
20
400

.00000126
400
.00050400

Five feet of wire weighs 1841 grains

Cu. ft. of wire weighs 555 lbs

1728)555.0(.3211 lb in cu. in.
5184
3660
3456
2040
1728
3120

.3211
7000
2247.7000 grains in cu. in.

6.0)184.1
~~22.35~~
30.68 per inch lengths of wire in grains

22.35)2247.70(100.5
1.0050 .00995
.00995 Cu

3.14).009950(.003160
942
530
314
2160

Wire 112 inches

Diameter by Molesworth from the wi

By weight see page 153

15 : 101.16 :: 55227
101.16
331362
55227
55227
55227

Total Wt. Grains

15)5586763332(37245
45
108
105
36
30
67
60
76

2247)30.68(.0136 sq inches
22.47
08210
8210
6741
14990
.132 = D

Molesworth
~~.1318~~ = Diameter
.1318 inches

l

101.16
101.16
60696
10116
10116
10116
1023334 56

l^2

.2064
40932
61398
20466
21120

3.7245)2112.00(.0567
~~22377.0~~
186125
250750
~~715~~
223510
272400

r = .0567
.0765
3955
3402
3969
.00434875
.0567
.061 Ohms Phila sample

.060) .061 (101.6 % by weight
60
100
60
100

.060) .06593 (109.9 % by size
60
593
540
53

Sp. Gr. 8.96 Lawson

These results seem impossible yet great care was taken. The tape was new by which the length was measured and the wire was not stretched but measured by laying the tape at its side.

Sample for Dynamo

169 Feet of wire at 61.97 .0411 inches in diameter gave a resistance of 1 Ohm

411
411
411
411
1644
168921

9.718
169
87462
58308
9718
1689) 1642342 (975
15201
12224
11423
8010

.003824
16.6
22944
22944
3824
.0634784
975
3170
4438
5706
6181.50
97.5
103.6 %

166.25 feet of wire $\frac{41.3}{1000}$ in in diameter at 62° 57 gave a resistance of 1.ohm

413
413
1239
413
1652
1705.69

971.8
166.3
29154
58908
58908
9718
1705) 1622.7034 (95.2
15345
8820
8535
2850

.0634
952
1268
3170
5706.
602968
95.2
101.2%

Test of Faradic machine
.037 plates 1100 Revo

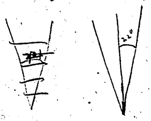
N7 running field open
1,020 lbs.
Card No. 1, 2.
In the line 2.66.. Ohms.
time 2.23. P.M.
2.26. P.M. No 3. Card.
On high resistance 336 = Deflection
Dynamometer 820. lbs. 20
In the line 3.05. Ohms.

Cards taken from the crank side of the piston Nos. 1.2.3.4 & 5.

Armature making 1129 / 1126. R.P.M.
Main shaft making 186. R.P.M.
" " " 366 R. in two minutes.

Dynamometer 1,000 / 1,010. lbs. field on.
Card 6.7.8 & 9. far end of cyl.
Dynamo on.

$\frac{1}{2}$ Angle between belts 22°



Steam cyl. 16" bore = 201 sq." area.
42" stroke at 60 revs, average speed = 60×7' = 240' p.m.
Card No 1 - average pressure 4.8 lbs per sq. inch.
$\frac{96}{20}$ =
" No 3 $\frac{133}{20}$ = ——— 6,65 lbs per sq. inch.
No 6 6.8 lbs per sq inch
No. 9. 4.3 lbs

X. 2

201
240
8040
402
48240
4.8
385920
192960
230,552.0 | 6.92 H.P.
198
325
307
85

6.92
2
13.34 H.P.

230552
2
461110

48240
6.65
442300
289440
289440
322807.00 | 9.78 H.P.
297
258
231
270

9.78
6.92
2.86 H.P. Dynamo

322807
230552
192245

Indicator 209.360 ft. lbs -

6.65 6.8
4.8 4.8
185 2.5
1.85
4.35
2.17

48.240.
2.17
337680
4824
9648
104,680.80
2 2
209.360 ft. lbs

Dynamometer
185 ~~Belt~~ Shaft speed

3.14
38
2512
942
12) 119.32
.993

Circumference pulley for belt

10.02
.09
10.11 feet

38 119.3
38 3/8 120.4
1.1 inches for belt

1.1/12) 1.10 (.09
108
14

Angle 22° Cos 22° = .927

~~[illegible]~~

.927) 1000 (1.08
927
7300

10.11
1.08
8088
1011
Corrected size 109188

10.91
185
5455
8728
1091
2018.35
200
2) 403600
33) 201800 (6.1 H. P.
198
37

112
112
224
112
112
12544
443
37634
50176
50176
3 | 555699.2
185233 ft. lbs. in current

.14 Ohm machine
about .11 " in leading wires
.25) 3 (12

1/12 of this in machine
and leading wire

72) 185.233
15436
200669 ft. lbs. engine indicated
209 360 ft. lbs. given machine dynamo
202 700 ft. lbs. back in current
200.669 measured galva.

Shop and engine require
461,110 ft. lbs.

Large armature thick
plates: surface speed =

Resistance of [illegible]
new large Faradic Machine
2.1 Ohms.
Temp. 16° C.

9 A M Started

D = 270 from .034 plates
20 cells Daniells 239 = D
D = 92 on magnet

---

20) 23.9
11.9) 92.0 (7.73
833
870
833
33

7.73
1.08
6184
773
8.3484

9.45. A.M. 22° C.

Changed the field

240 = Ω from 20 Daniells
120 = Ω around magnets
9 55 to
10 35 a.m. 28°0 Rise 6° C

Started 10-45 a.m.

20 cells = 39

10-50 120 on magnet

12 m 33° C

Magnet face 23° C

This test shows that the field was very weak

Lunch - 20 P.M. ~~Ø~~

1-20 P.M. Armature 31° C

Magnet face 22° C

4 per H.P.

33000
2)8000 ft lbs
4000 ft lbs per Ohm

20 Volts

20
10.8
21.6 : 20 :: 240

21.6) 4800 (22
432
480

P.M. 1-45 240 20 cells

220 on magnet

226

Time	
2-45	Temp room 21°C
	Armature 38°C
2-55	Started
	226 = Δ around magnet
4 00	Temp room 19°C
	Armature 43°C
410	Started
510	Temp. room 20°C
	Temp armature 46°F

227

Time	
5-20	Started
8-45	54.5°C
8 50	l
10 AM	56°C

188.
38

2.27416
1.57978
.49715
.02179

4.37288
8.92082

3.29370

12 ⟌23590
1

196600

5.878

Heating Exps

page 140
174
175
177
200
206
207
208
209
210
221
232
233
253 large

~~C=~~

$$C(R+r+q) = \frac{C}{1}(\rho+r+q)$$

$$\cancel{cR + rc + qc = \frac{\rho c + rc + qc}{1}}$$

$$\cancel{\frac{cR + rc + qc}{1}} = \cancel{\frac{\rho c + rc + qc}{1}}$$

$$+\frac{cR =}{1} = \frac{\rho c}{x} \text{ ans}$$

$$cR + xc + qc = \frac{\rho c + xc + qc}{1}$$

$cR + \rho c$

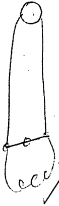
95
95
475
855
9025
44
36190
36100
39710
6/3971
6-618.3

+

-4

[redacted]

21



6 / 596000

9.9333

6

595998

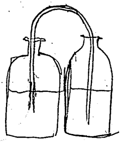
Order 2 lbs Sulphate Zn. C. P.

50 〃 〃 〃 Com

〃 2 lbs Sulphate Cu. C. P.

Get Electrometer

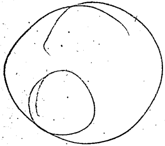
Make 4 cells of C.P. material



145
745
723
580
145
210 23 = 95
44 45
140
84100 .6,
84100 700,
6)923100
154183 — 2

33
4
132000
16500
148,500

0,



145
145
5

140
140
140
560
140
19744
44
7896
78960
78960
86856
6)8.6856
144,760

195
195
975
1755
195
38025

18
18
144
18
324

326
60
19560

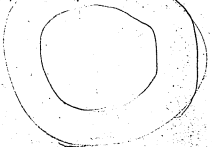
324)380(19560

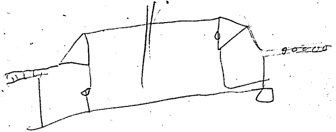
19.56 mg

324)380(114
324
560
324
1360

33
4
132000
16500
148,500

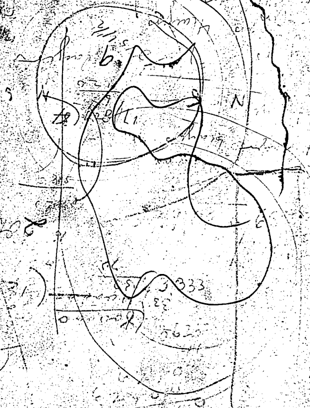
33
5
165.





140

100


b
N
S
N
L1
6
333

7

5
60

133

130
130
1 3 0

3 0
7 0 3 0
2 0

2 4 8 8 6